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PRINCIPLES AND METHODS OF TEACHING MATHEMATICS. INNOVATIVE EDUCATIONAL TOOLS

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Abstract. In this article, the modern didactic principles of teaching mathematics, effective pedagogical methods, and the use of innovative educational tools are highlighted. It has been scientifically analyzed that applying key didactic principles—such as scientific approach, conscious activity, regularity, consistency, and visuality—directly affects the quality of mastering mathematics. In addition, the study examines the practical effectiveness of problem-based learning, the project approach, inquiry-based teaching, and the competency-based approach alongside traditional methods. As innovative educational tools, the possibilities of digital platforms, online services, interactive simulators, artificial intelligence technologies, AR/VR systems, and electronic resources have been explored. The results show that the use of innovative methods and technologies in mathematics lessons significantly increases students' logical thinking, creativity, and motivation. At the end of the article, methodological recommendations and suggestions are presented.

Keywords: Mathematics education, didactic principles, teaching methods, innovative technologies, digital education, competency-based approach, artificial intelligence, AR/VR, interactive methods, modern pedagogy.

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Introduction.

The methodology of teaching mathematics is an important component of pedagogical science. This field studies in what form, through which methods and didactic tools, the content of mathematics should be delivered to students. The reforms being carried out in the education system require improving the content, form, and means of teaching mathematics. Therefore, the principles, methods, and use of innovative technologies in teaching mathematics have become one of the most urgent issues today.

Teaching mathematics is based on the general didactic principles, which are manifested in specific forms depending on the nature of the subject. The principles of teaching mathematics include the following:

Scientific principle – mathematical learning material must be scientifically grounded, and concepts must be presented on a strictly logical basis. Formulas, theorems, and rules should be provided together with their proofs, which form the core of scientific validity.

Systematic and consistent principle – mathematical content is taught in a logical sequence, step-by-step, from simple concepts to more complex ones. Each new topic must be firmly connected with previously acquired knowledge.

Consciousness and activity principle – the student should not receive mathematical material in a ready-made form, but must actively participate in understanding, analyzing, and drawing conclusions. This develops independent thinking.

Visual principle – mathematical concepts are easier to learn when explained using graphs, diagrams, models, geometric figures, and tables. Visuality includes not only images but also logical illustrations — proofs and examples.

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Strength principle – knowledge is reinforced through regular exercises, repetition, and practical tasks. To ensure a high level of retention, repetition must be systematic.

Unity of theory and practice – mathematical theory is taught in connection with real-life problems and applied examples based on equations and inequalities. This contributes to the development of students' competencies.

Methods of teaching mathematics are a set of pedagogical techniques that organize the process of acquiring, analyzing, and applying knowledge. Choosing the correct methods increases lesson effectiveness and develops students' logical thinking. Examples of mathematics teaching methods include:

Verbal methods — explanation, conversation, narration, question–answer. These methods form the basis of the theoretical part of mathematics.

Visual methods — explaining topics using graphs, diagrams, and models.

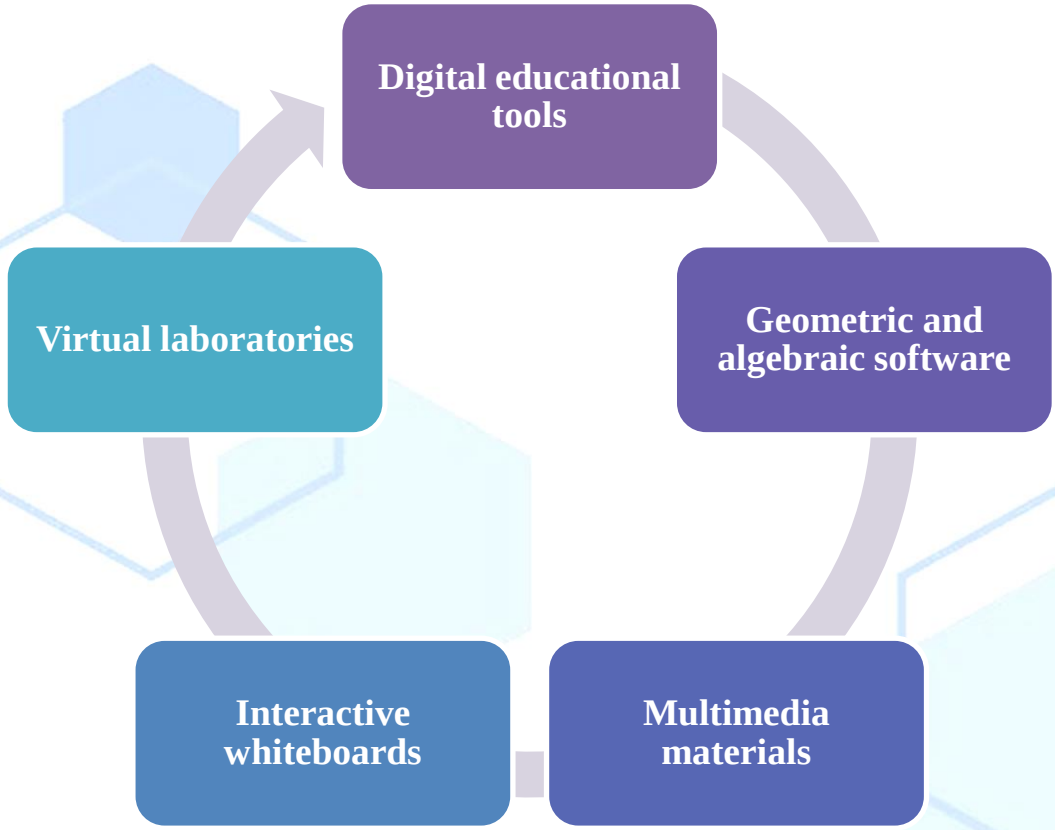
Practical methods — solving problems, independent work, performing practical exercises, which strengthen the link between theory and practice.

Problem-based learning — presenting problems, encouraging students to search for solutions, and guiding them toward independent conclusions.

Interactive methods — using techniques such as "Brainstorming," "Cluster," "Insert," "Jigsaw" to increase student engagement.

STEAM approach — integrating mathematics with technology and engineering to develop practical competencies.

Innovative educational tools



Conclusion:

The effectiveness of mathematics instruction depends critically on the careful selection and coherent application of teaching methods and didactic resources. When classical didactic principles—such as clear lesson structure, gradual progression from concrete to abstract, and systematic reinforcement—are combined with contemporary, research-based instructional technologies, the result is a richer and more motivating learning environment. Innovative tools (for example, dynamic geometry software, adaptive practice platforms, and multimedia visualizations) can increase student engagement by presenting mathematical ideas in multiple representations and by allowing learners to experiment and receive immediate feedback. At the same time, adherence to proven pedagogical principles ensures that novelty does not compromise conceptual clarity or the development of rigorous problem-solving skills.

A modernized approach to mathematics education brings several concrete benefits. First, it stimulates students' intrinsic interest in the subject by making abstract

concepts more tangible and relevant. Second, it supports the development of logical and analytical thinking through tasks that require reasoning, pattern recognition, and justification. Third, it helps cultivate core mathematical competencies — procedural fluency, conceptual understanding, strategic competence, and the ability to communicate mathematical reasoning. Combined, these outcomes improve not only short-term performance on tests but also long-term mathematical literacy and transfer of skills to new contexts.

To realize these benefits in practice, teachers should pursue an intentional instructional design that integrates technology with traditional methods rather than replacing them outright. This includes selecting technologies that align with learning objectives, sequencing activities so students first build intuitive understanding and then formalize ideas, and using formative assessment to guide instruction. Professional development and collaborative planning are also essential so that teachers can interpret student-generated data, design effective tasks, and scaffold appropriately. Finally, equitable access to tools and differentiated supports must be provided so that all learners — regardless of prior preparation — can benefit from innovation.

In summary, the thoughtful synthesis of innovative technologies and classical didactic principles enhances the content and processes of mathematics lessons, raises student motivation, strengthens reasoning skills, and contributes to the development of robust mathematical competencies. When implemented with clear objectives, ongoing assessment, and teacher support, this integrated approach leads to measurable improvements in the quality of mathematics education.

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